Armed Forces College of Medicine

AFCM

Cardio-Pulmonary Physiology

Lecture 10: Circulatory Hemodynamics (2)

INTENDED LEARNING OBJECTIVES (ILO

By the end of this lecture the student will be able to:

1. Describe differences in the blood velocity in the various vascular segments in relation to their total cross-sectional area.
2. Describe the factors that affect the vascular resistance.
3. Describe why the resistance in the capillaries is low and blood flow is slow.

- **Do you think there is a difference in Blood Flow between**

Systemic & Pulmonary circulations ???

ΔP across Systemic Circulation

- **<u>At the start of the circuit</u> (Heart)**

  MAP in the aorta = 90 mmHg

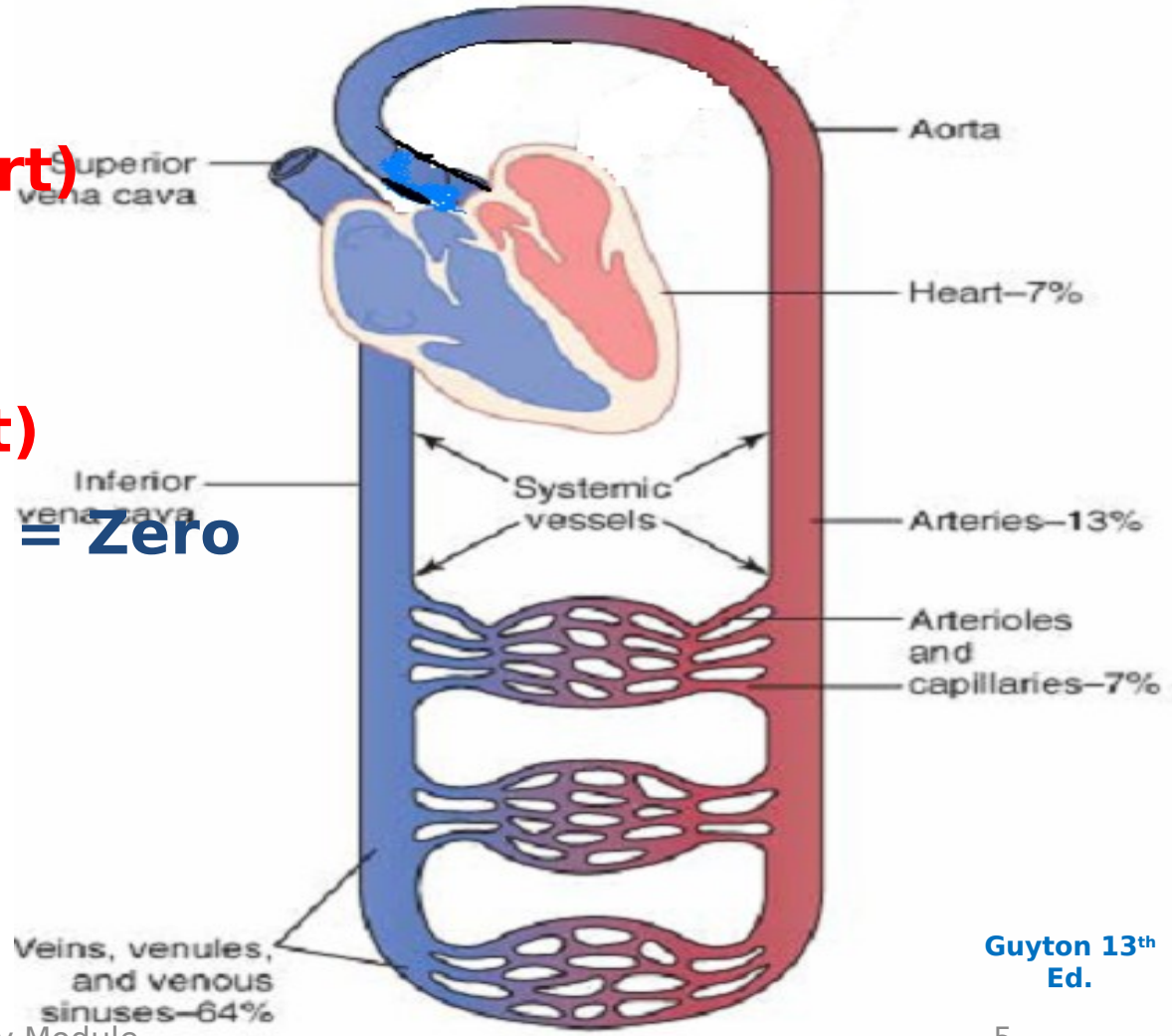
- **<u>At the end of the circuit</u> (Heart)**

  Pressure in the Rt. atrium (RAP) = Zero mmHg

- **ΔP = MAP - RAP**

  = 90 - 0

  = 90 mmHg



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ΔP across Pulmonary Circulation

- **<u>At the start of the circuit</u> (Heart)**

  MPP in the pulmonary artery = 15 mmHg

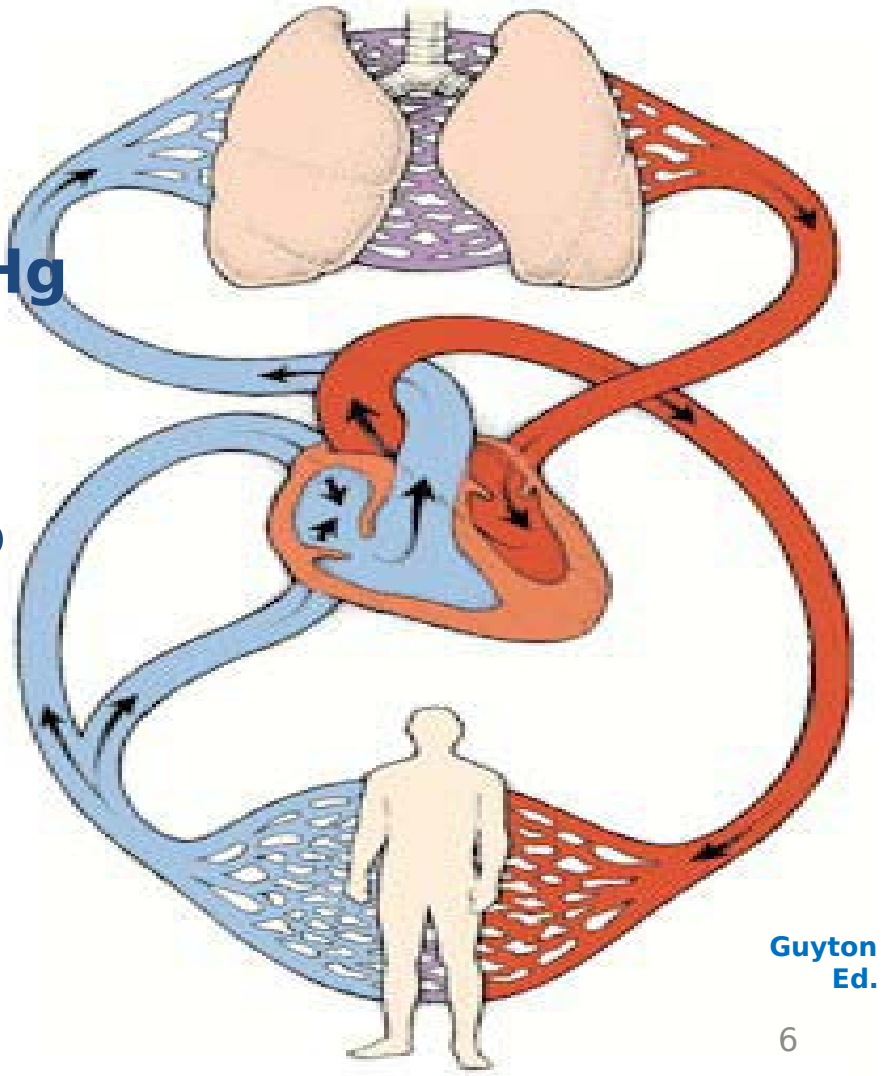
- **<u>At the end of the circuit</u> (Heart)**

  Pressure in the Lt. atrium (LAP) = Zero mmHg

- **ΔP = MPP - LAP**

  = 15 - Zero

  = 15 mmHg



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- **What are your expectations about the Vascular Resistance offered by Systemic & Pulmonary vessels ???**

Systemic Vs. Pulmonary Vascular Resistance

SVR	PVR
- $R = \frac{\Delta P}{COP}$ $= \frac{MAP - Rt.\ atrial\ P}{COP}$ $= \frac{90 - 0}{5}$ = 18 mmHg/L/min	- $R = \frac{\Delta P}{COP}$ $= \frac{MPP - Lt.\ atrial\ P}{COP}$ $= \frac{15 - 0}{5}$ = 3 mmHg/L/min
- 6 – 10 times higher than PVR	- 1/6 – 1/10 times higher than SVR
- Autonomic control is strong	- Autonomic control is weak

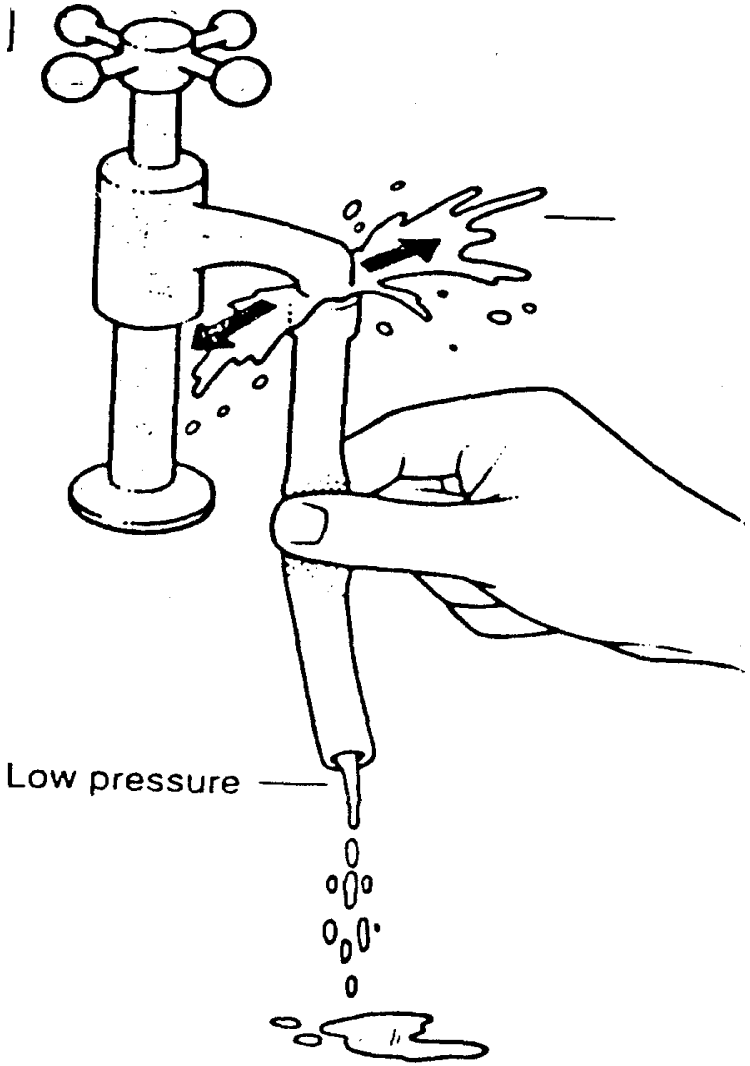
Pulmonary Vascular Resistance (PV

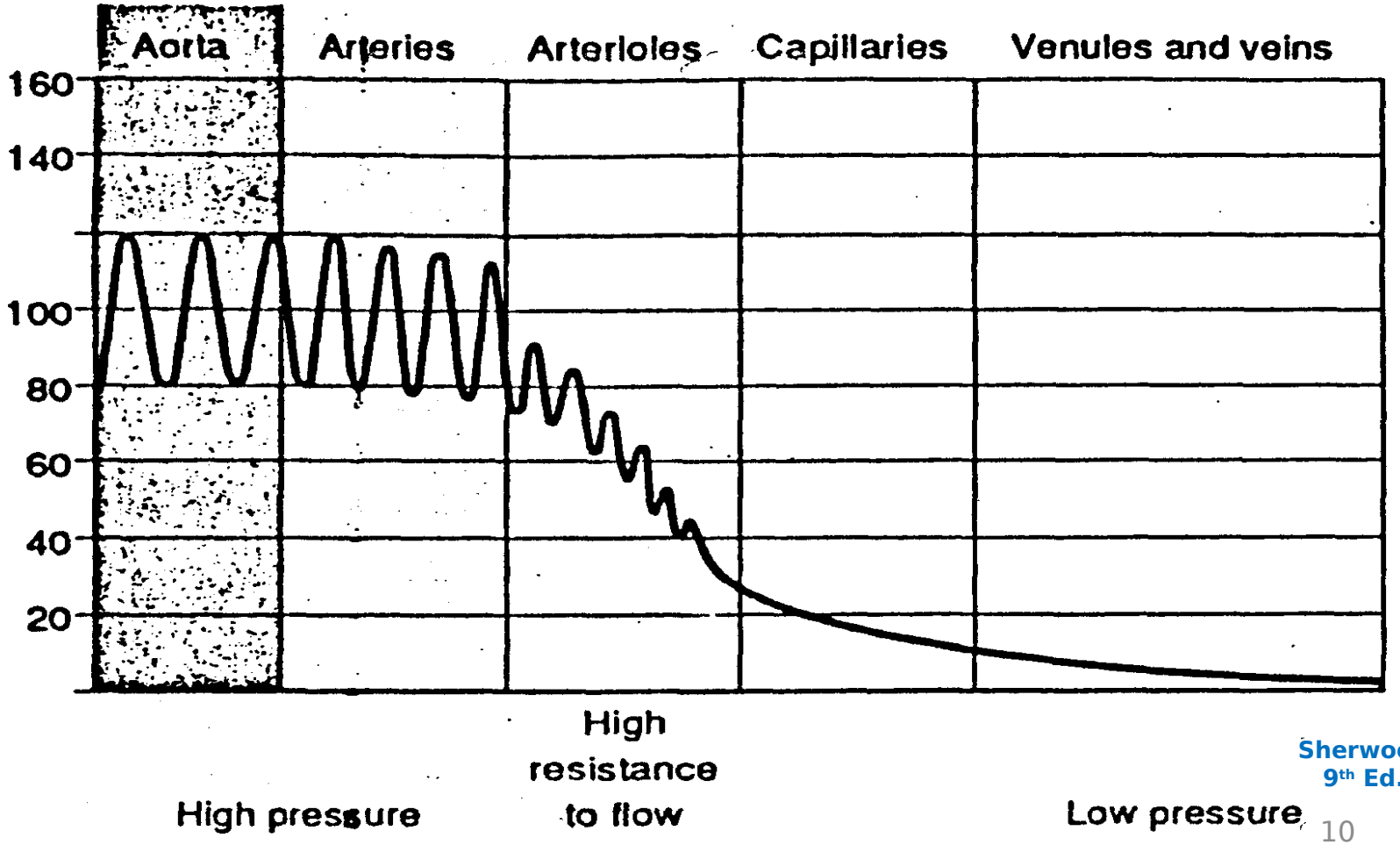
The pulmonary vessels are:

1. **Wide diameter**
2. **Short**
3. **Scanty muscle fibers →→ weak nervous control**

$$R = \frac{8\ L\ \eta}{\pi\ r^4}$$

	Arteries	Arterioles	Capillaries	Veins
Resistance (of total %)	**% 15**	**% 50**	**% 25**	**% 10**





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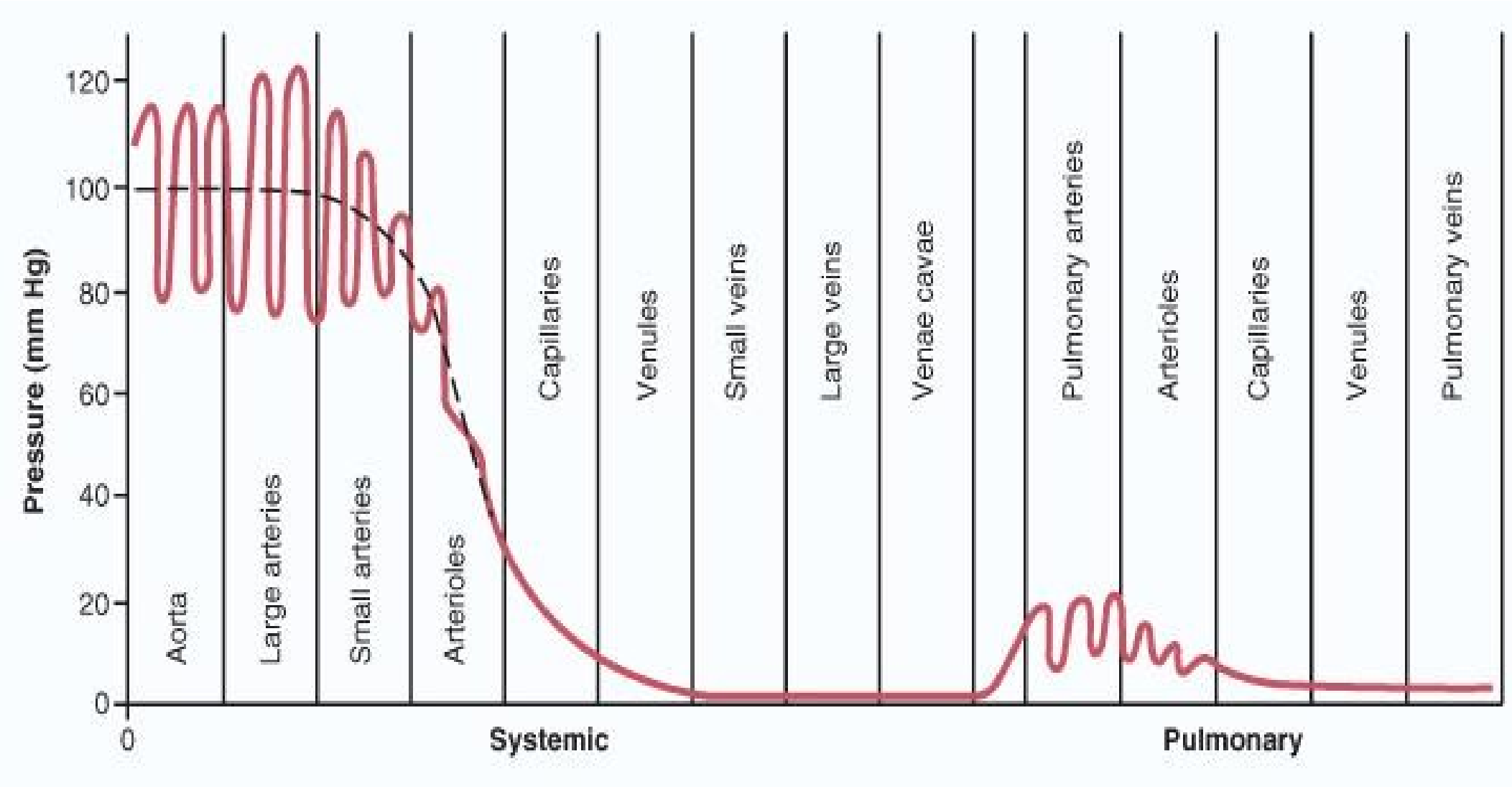
Vascular Resistance



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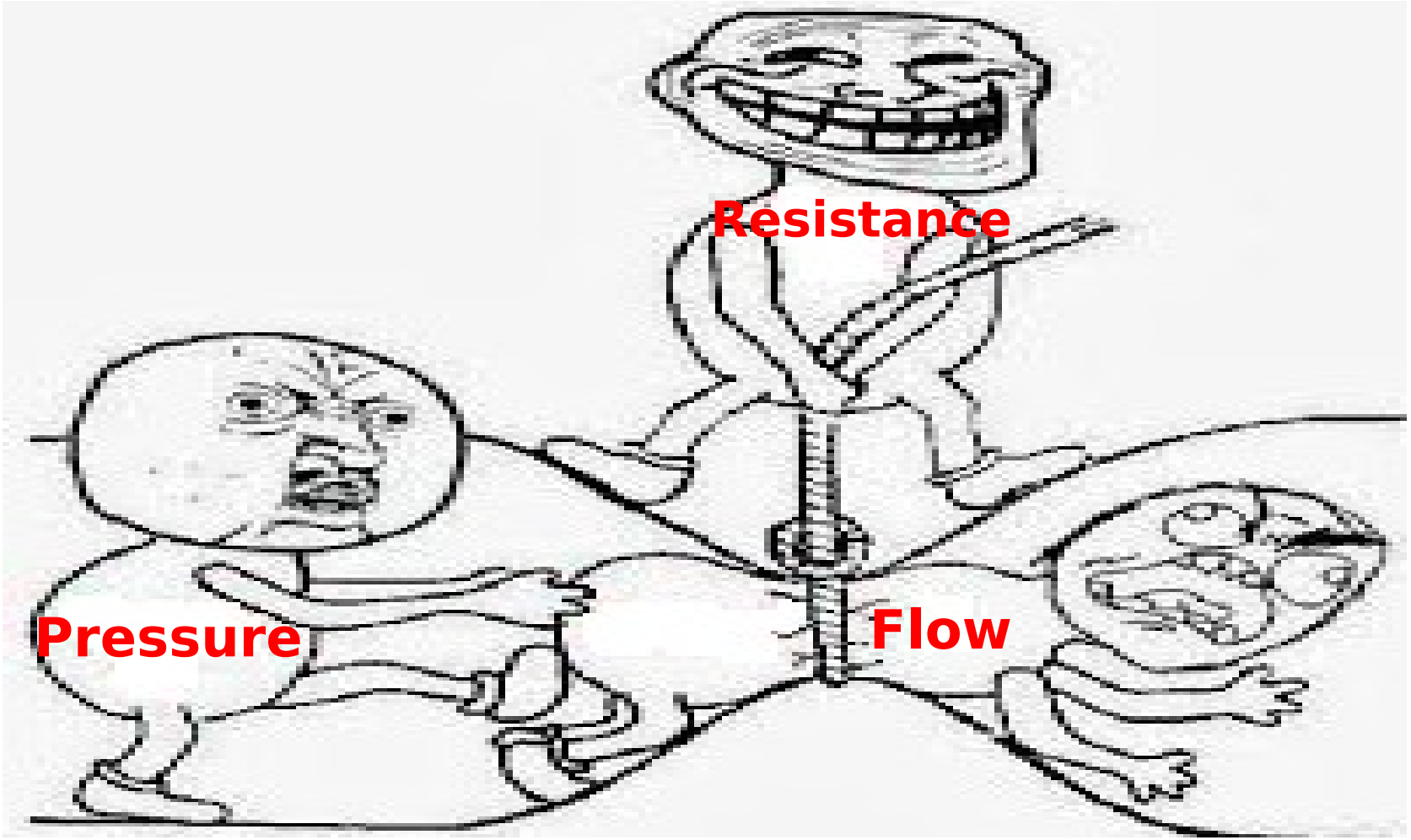
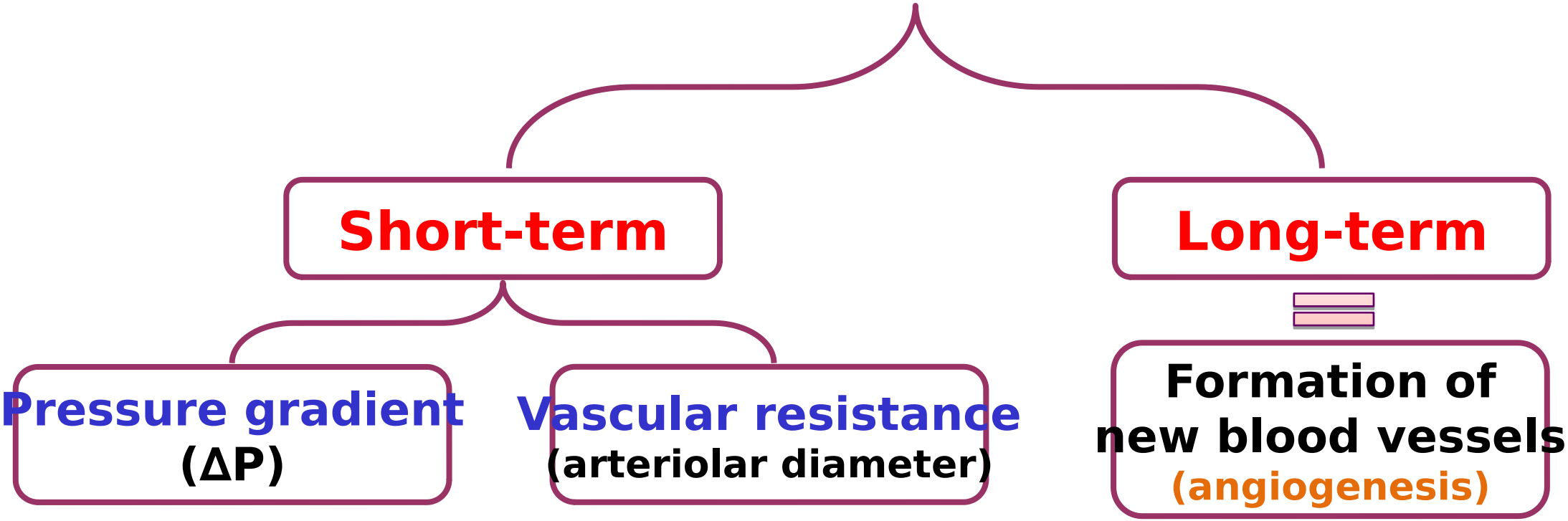
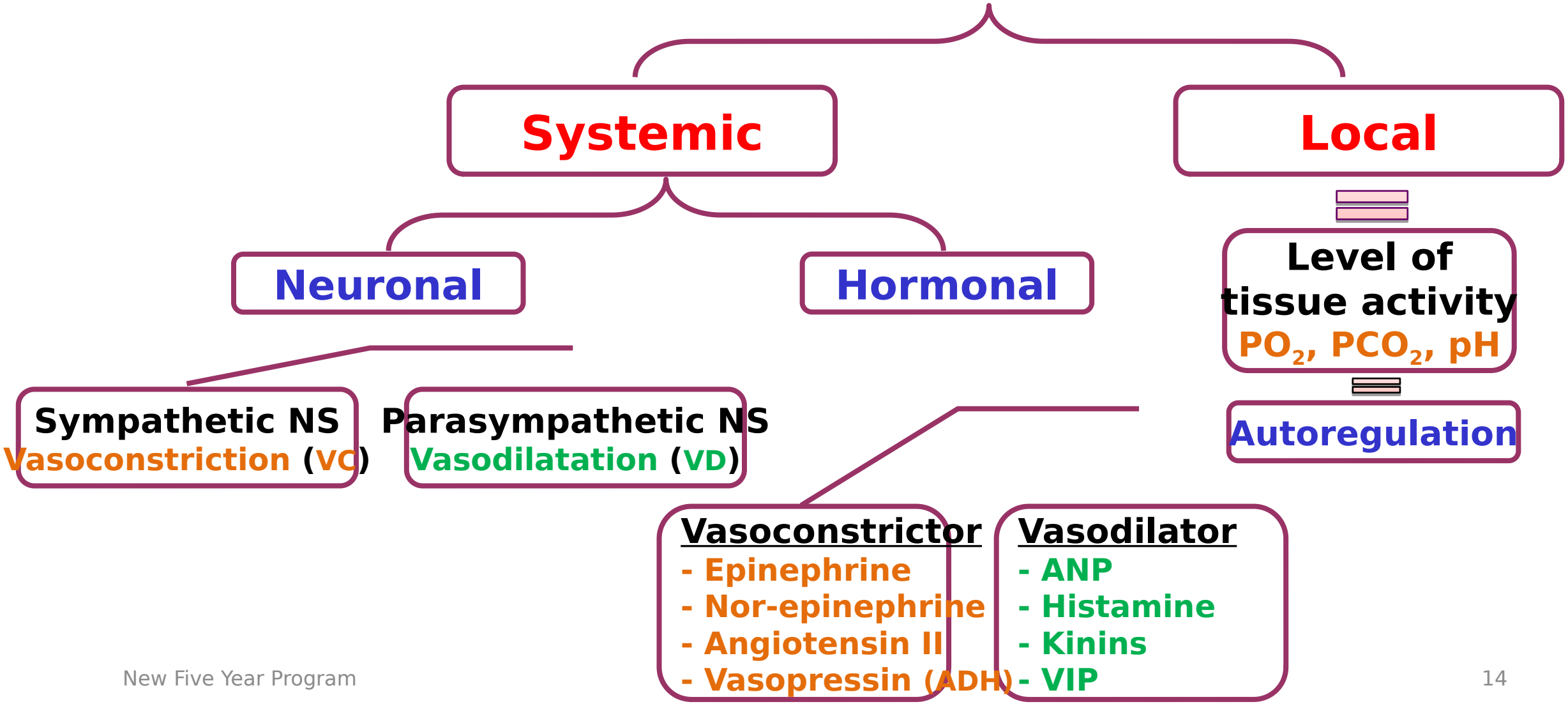
Regulation of Tissue Blood Flow



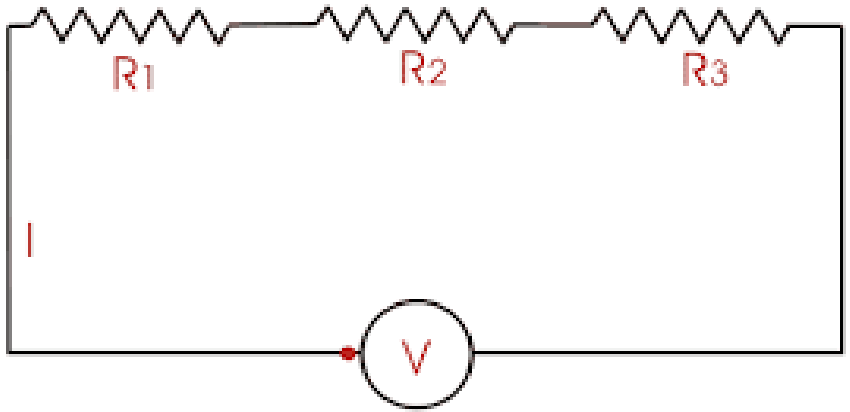
Regulation of Tissue Blood Flow



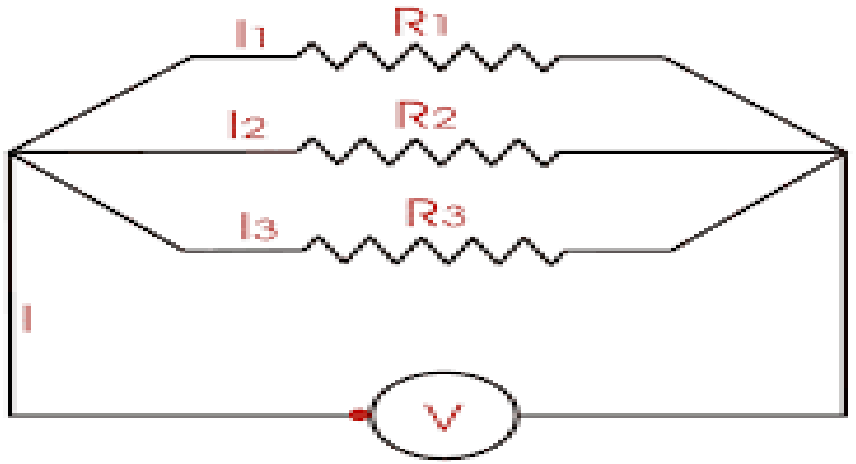
Control of Arteriolar Diameter (Resistan



Connection in Series Vs. Connection in Parallel

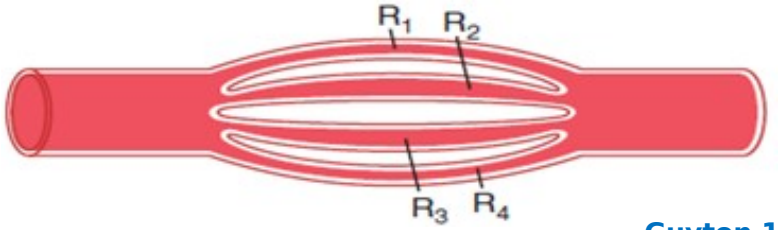


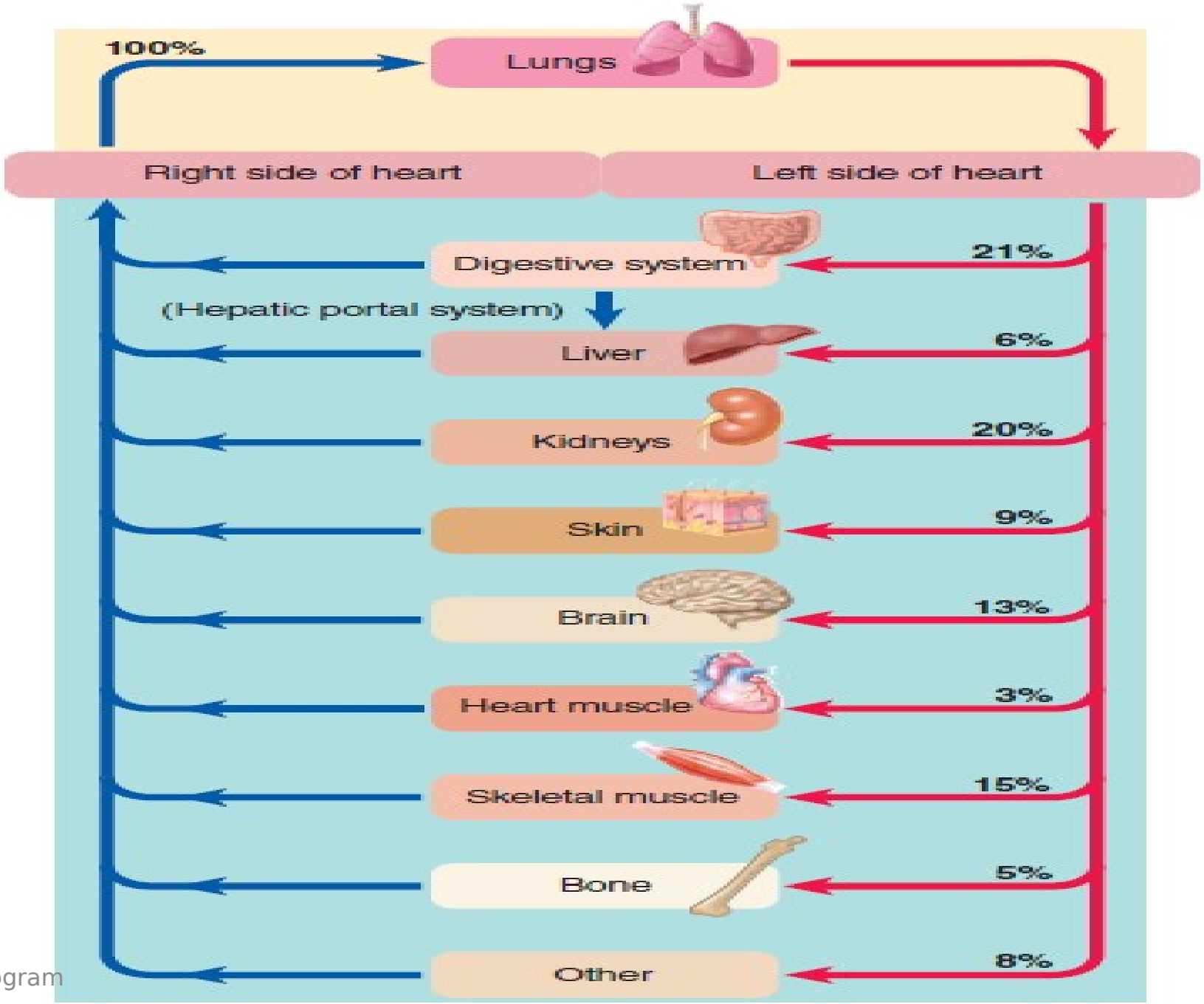
Series Circuits



Parallel Circuits

Connection in Series Vs. Connection in Parallel

	Series Circuits	Parallel Circuits
		 Guyton 13th Ed.
Resistance	- High - Equal to the sum of resistances in all vessels passing through	- Low - Equal to the resistance in that vessel only
Blood Flow:		
a. Quantity	The same in all tissues passing through	Its own share
b. Quality	Less oxygen content (leftover)	Pure arterial (high oxygen content)
		Highly adjusted



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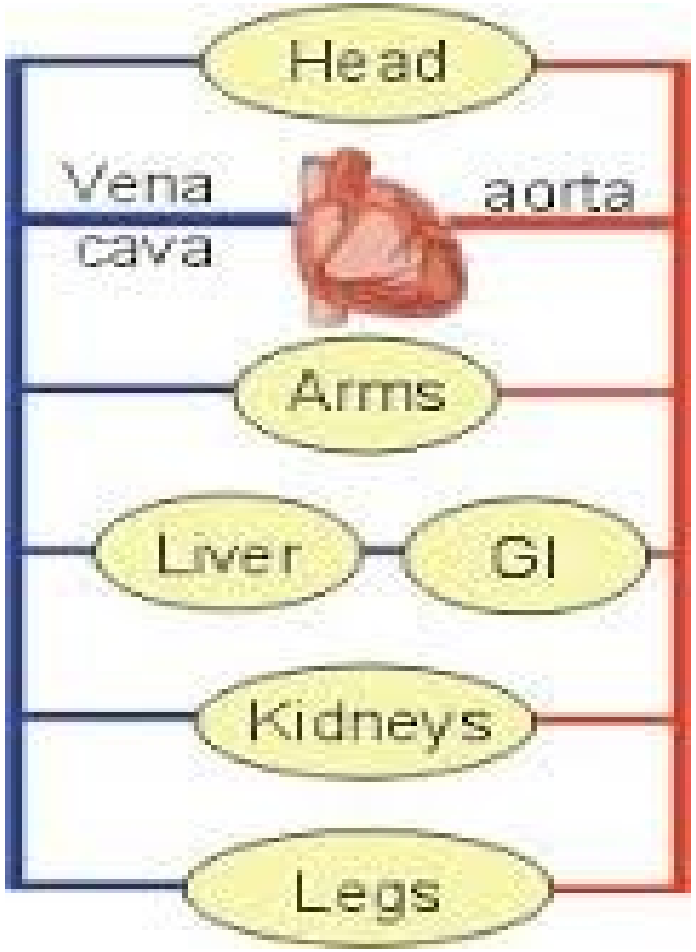
Connection in Series Vs. Connection in Parallel



Relationship between: Flow & Veloci

Velocity

- Is the displacement of blood per unit time
- It can be calculated according to the following formula :

$$V = F / A$$

V : Velocity of blood
F : Flow of blood
A : Cross Sectional Area (CSA)

Relationship between: Flow & Veloci

Cross Sectional Area **(CSA):**

- **Total CSA represents the diameters of all vessels of the same type, put side by side**

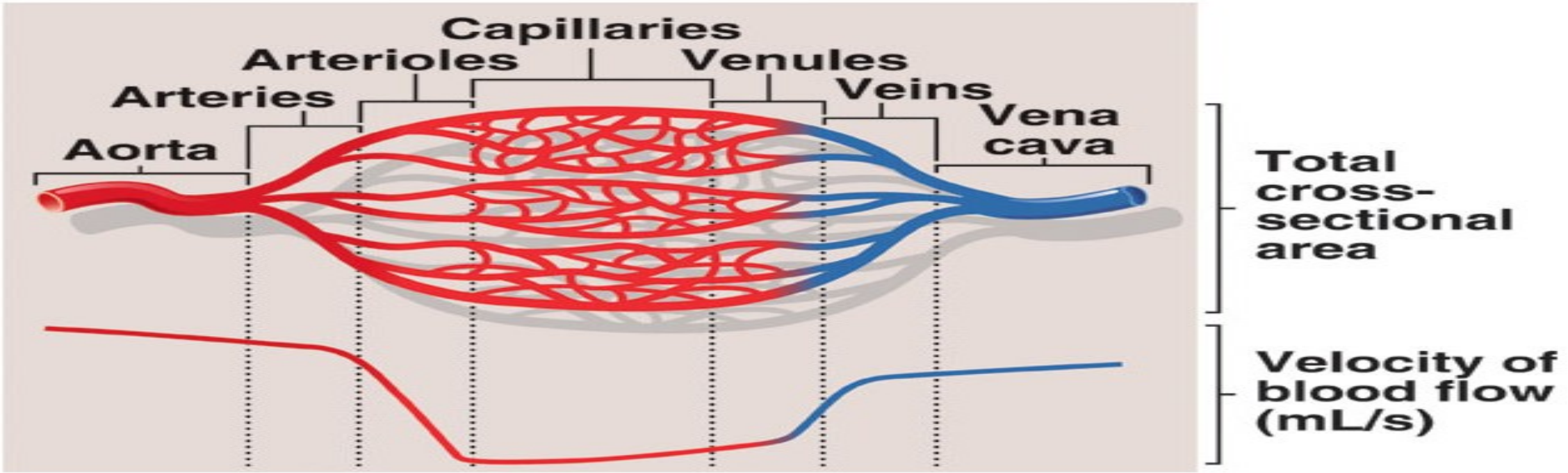
- **CSA of capillaries > Aorta**
- **Velocity in capillaries < Aorta**

(0.5 mm/sec) (0.5 m/sec)

- **Measurement of velocity:**

a- Arm -to- Tongue (bile salts)
b- Arm -to- Lung (ether)

Velocity & Cross Sectional Area



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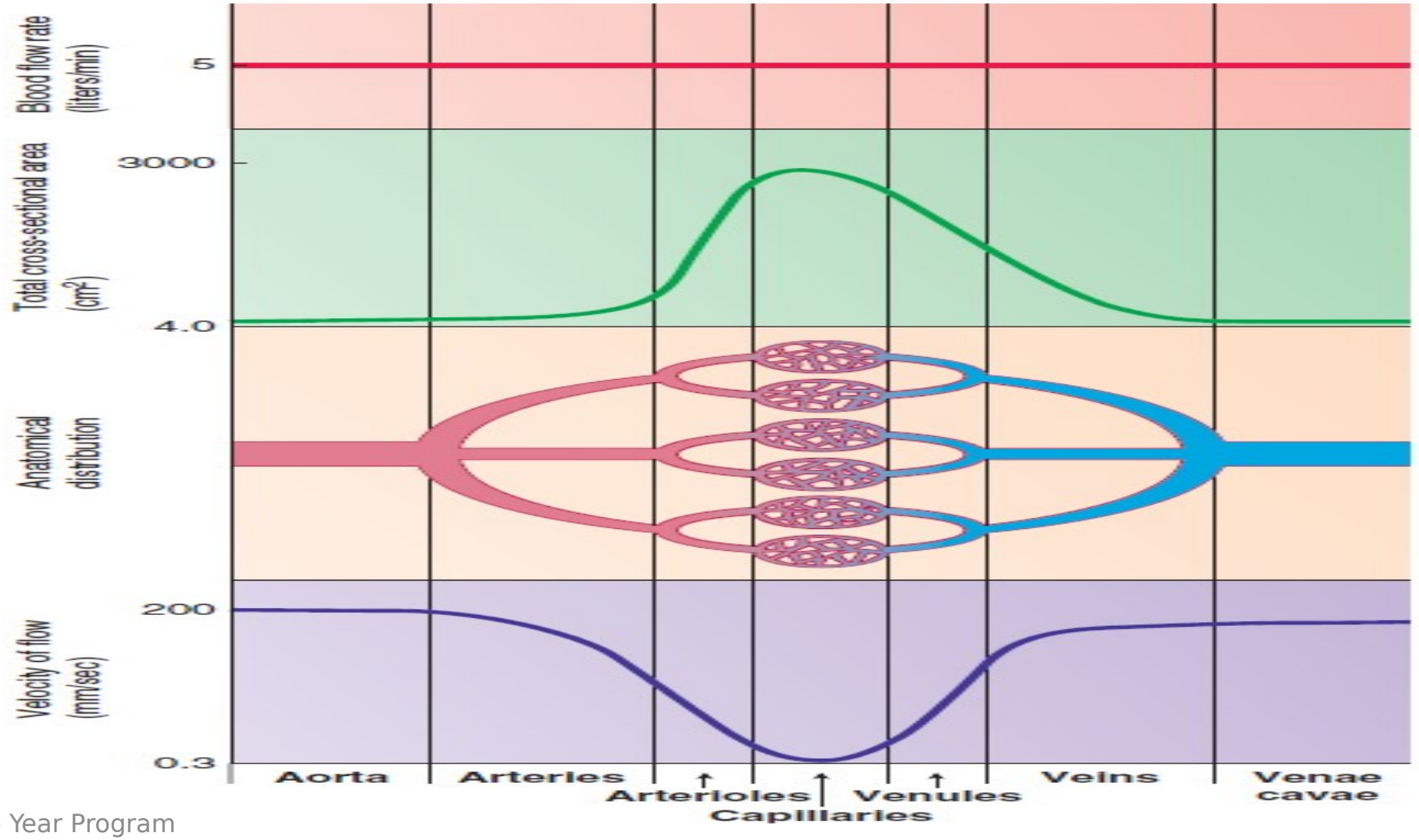
https://oculo-facial-surgery.info/relationship-between-and/relationship-between-blood-pressure-velocity-and-cross-sectional-area.php

Velocity & Cross Sectional Area

Vessel	Total Cross Sectional Area (CSA, cm^2)
- Aorta	2.5
- Small arteries	20
- Arterioles	40
- Capillaries	2500
- Venules	250
- Small veins	80
- Venae cavae	8

Velocity & Cross Sectional Area



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SUGGESTED TEXTBOOKS

1. **Guyton and Hall**
   Text book of Medical Physiology, 13th Edition (2016), Chapter 14 (**Overview of the Circulation; Biophysics of Pressure, Flow, and Resistance**)

2. **Ganong's**
   Review of Medical Physiology, 24rd Edition (2012), Chapter 31 (**Blood as a Circulatory Fluid & the Dynamics of Blood & Lymph Flow**)

3. **Fox**
   Human Physiology, 14th Edition (2016), Chapter 14 (**Cardiac Output, Blood Flow, and Blood Pressure**)

4. **Sherwood**
   Human Physiology .. From Cells to Systems, 9th Edition (2016), Chapter 10 (**The Blood Vessels and Blood Pressure**)


THANK YOU